PVP 23

Code: 23EE3301

II B.Tech - I Semester – Regular / Supplementary Examinations
NOVEMBER 2025

ELECTRICAL CIRCUIT ANALYSIS - II
(ELECTRICAL & ELECTRONICS ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

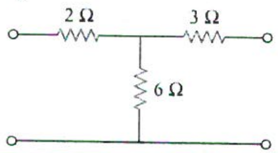
BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	How do you find the average and RMS values of a non-sinusoidal periodic waveform using Fourier coefficients?	L2	CO1
b)	What is the relationship between the trigonometric and exponential forms of a Fourier series?	L2	CO1
c)	Express the relationship between Z and Hybrid (h) parameters.	L2	CO2
d)	Why h-parameters are called as 'hybrid' parameters?	L2	CO2
e)	Distinguish between the natural response and the forced response of a circuit.	L2	CO3
f)	What is the condition for a series RLC circuit to be underdamped, overdamped and critically damped?	L2	CO3
g)	List the advantages of a three-phase system over a single-phase system.	L2	CO4
h)	How can the power factor of a balanced three-phase load be determined from the readings of two watt meters?	L2	CO4
i)	Define the cut-off frequency for a filter.	L1	CO5

	j)	Draw the equivalent circuit of a typical band-pass filter.	L3	CO5

PART – B

			BL	CO	Max. Marks
UNIT-I					
2		Solve the Laplace transform of the following functions: a) $f(t)=e^{-at}\sin(\omega t)$ b) $f(t)=t^2u(t-1)$	L3	CO1	10 M
OR $e^{-s}\left[\frac{2}{s^3}+\frac{2}{s^2}+\frac{1}{s}\right]$					
3		Determine the Laplace transform of the periodic sawtooth waveform. $\frac{A}{Ts^2} - \frac{A\,e^{-Ts}}{s(1-e^{-Ts})}$	L3	CO1	10 M
UNIT-II					
4		Find the z-parameters of the two-port network shown in the figure.  $\begin{bmatrix} 8 & 6 \\ 6 & 3 \end{bmatrix}$	L3	CO2	10 M
OR					
5	a)	Derive the expressions for converting Y-parameters into ABCD (transmission) parameters.	L3	CO2	5 M
	b)	Determine the transmission parameters for a two-port network, Given Z-parameters are $Z=\begin{bmatrix}10 & 5\\ 3 & 8\end{bmatrix}$. $\begin{bmatrix} 3.33 & 21.67 \\ 0.333 & 2.67 \end{bmatrix}$	L3	CO2 $\frac{z_{11}}{1}$	5 M $\frac{\Delta z}{z_{22}}$ / z_{21}
UNIT-III					
6		A series RLC circuit with R=5 Ω, L=1 H and C=0.25 μF is excited by a 100 V DC source at t=0. Obtain the expression for the current i(t) using the Laplace transform approach.	L4	CO3	10 M

$-\frac{Y_{22}}{Y_{21}}$ $-\frac{1}{Y_{21}}$ $-\frac{\Delta Y}{Y_{21}}$ $-\frac{Y_{11}}{Y_{21}}$

$\begin{bmatrix} 10/3 & 65/3 \\ 1/3 & 8/3 \end{bmatrix}$

$-2.5 \pm j2000$

$e^{\alpha t}[A\cos\beta t + B\sin\beta t]$

$0.05\,e^{-2.5t}\sin 2000t$

OR					
7	a)	Develop an expression for the step response of a series R-C circuit.	L4	CO3	5 M
	b)	Derive the general expression for the current response of a series R-L circuit excited by a sinusoidal voltage source, $V=V_m\sin(\omega t+\theta)$.	L4	CO3	5 M
UNIT-IV					
8	a)	Derive the relationship between line currents and phase currents in a star-connected three-phase balanced system.	L3	CO4	5 M
	b)	The two-wattmeter method produces readings of 1500 W and 750 W when connected to a delta-connected load. Calculate the total active power, total reactive power and the power factor of the load. 2250 W 1299.04 VAR 0.866	L3	CO4	5 M
OR					
9		A balanced star-connected load with an impedance of (12 + j15) Ω per phase is connected to a three-phase, 400 V, 50 Hz supply. Determine the line currents, power factor and total active power consumed by the load.	L4	CO4 12.82 ∠−51.34 A 5.2 kW 0.62	10 M
UNIT-V					
10	a)	Design a constant-k high-pass T-section and π-section filter with a cut-off frequency of 3000 Hz and a nominal characteristic impedance of 500 Ω.	L4	CO5	5 M
	b)	Explain the characteristics of a Constant-K high-pass filter with a neat diagram.	L3	CO5	5 M
OR					
11		Design a constant-k low pass filter having cut-off frequency of 4000 Hz (f_c) and a nominal characteristic impedance of 500 Ω. k.	L4	CO5	10 M

$L = \frac{k}{4\pi f_c} = 13.27$ mH

$C = \frac{1}{4\pi f_c k} = 0.053\mu F$

$L = \frac{k}{\pi f_c} = 39.79$ mH

$C = \frac{1}{\pi f_c k}$ 0.16 μF

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II B.Tech - I Semester - Regular/supplementary Examination

November 2025

Electrical circuit Analysis - II

(Electrical & Electronics Engineering)

1. a) - j) each question - 2M

2. a) Laplace transform of $e^{-at}\sin(\omega t)$ - 5M

b) " " " $t^{r} u(t-1)$ - 5M

3. ~~a~~ sawtooth waveform & Definition - 3M

Formulae - 2M

Laplace transform - 5M

~~4~~: z-parameter equations - 2M

Calculation of z_{11} - 2M

z_{12} - 2M

z_{21} - 2M

z_{22} - 2M

5. a) Y-parameter equations - 1M

A - 1M

B - 1M

C - 1M

D - 1M

b) Value of A - 1M

B - 2M

C - 1M

D - 1M

6. Circuit Diagram - 2M

Transformed " - 2M

KVL equation - 2M

solution of i(t) - 4M

7. a) Diagram – 2M
KVL equation – 1M
expression of $i(t)$ – 2M

b) Diagram – 2M
KVL equation – 1M
expression of $i(t)$ – 2M

8. a) Diagram – 2M
voltage relation – 2M
Current relation – 1M

b) Active power – 2M
Reactive power – 2M
power factor – 1M

9. Calculation of phase voltage – 1M
Z_{ph} – 1M
" " Line current – 3M
" " Active power – 3M
" " power factor – 2M

10. a) Formulae – 2M
Diagrams – 2M
Calculation of L & C – 1M

b) Diagrams – 1M
Any two characteristics – 4M

11. Formulae – 3M
Diagrams – 4M
Calculation of L & C – 3M

1.a) The average value of the periodic wave is

$$V_{avg} = \frac{1}{T}\int_0^T v(t)\,dt \quad \text{— (1M)}$$

$$v(t) = V_0 + \sum_{n=1}^{n} V_m \sin(n\omega t + \phi_n)$$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt} \quad \text{— (1M)}$$

b)

Trigonometric fourier series

$$f(t) = a_0 + \sum_{n=1}^{\infty} (a_n \cos n\omega t + b_n \sin n\omega t)$$

By substituting the cosine and sine terms

$$\cos n\omega t = \frac{e^{jn\omega t} + e^{-jn\omega t}}{2}$$

$$\sin n\omega t = \frac{e^{jn\omega t} - e^{-jn\omega t}}{2j}$$

exponential fourier series form $f(t) = \sum_{n=-\infty}^{\infty} C_n e^{jn\omega t}$

$$C_n = \frac{a_n - jb_n}{2} \text{ for } n>0$$

$$C_{-n} = \frac{a_n + jb_n}{2} \text{ for } n>0 \quad \text{— 2M}$$

$$C_0 = a_0$$

c) z interms of h

$$z_{11} = \frac{\Delta h}{h_{22}}$$

$$z_{12} = \frac{h_{12}}{h_{22}}$$

$$z_{21} = \frac{-h_{21}}{h_{22}}$$

$$z_{22} = \frac{1}{h_{22}}$$

(OR)

h interms of z

$$h_{11} = \frac{z_{11}z_{22} - z_{21}z_{12}}{z_{22}}$$

$$h_{12} = \frac{z_{12}}{z_{22}}$$

$$h_{21} = \frac{-z_{21}}{z_{22}}$$

$$h_{22} = \frac{1}{z_{22}} \quad \text{— 2M}$$

d) H parameters are called hybrid because they combine parameters with mixed units and dimensionless ratios (voltage & current ratios). — 2M

e) The main difference is that a natural response is a system behavior due to its initial conditions (e.g capacitor & Inductor), while a forced response is the behavior caused by an external function (voltage/ Current source). — 2M

g) 1. output of a 3-ϕ system is greater than that of a 1-ϕ system.

2. In a 1-ϕ system, the instantaneous power is fluctuating in nature. However, in 3-ϕ system it is constant at all times.

3. Transmission & Distribution of a 3-ϕ system is cheaper than that of a 1-ϕ System.

4. Three-phase motors are more efficient & have high power factors than 1-ϕ motors of the same frequency.

5. 3-ϕ are self-starting where as 1-ϕ motors are not self-starting.

Note:- Allot full marks for any two advantages — 2M

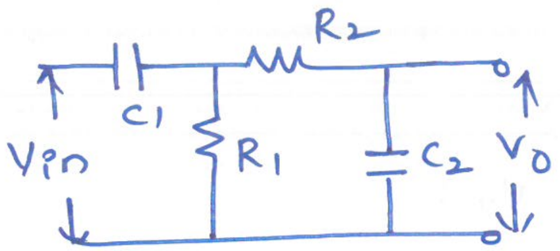
h) $$p.f = \cos\left(\tan^{-1}\left(\frac{\sqrt{3}(\omega_1-\omega_2)}{\omega_1+\omega_2}\right)\right)$$ — 2M

i) The cutoff frequency is the frequency at which a filters output power drops to half of its maximum value. — 2M

(OR)

It is the point where the filter begins to significantly attenuate the input signal. It is defined as the frequency at which the output signal drops to 70.7% of its maximum amplitude.

j).



— 2M

f) under damped $\frac{R}{2L} < \frac{1}{\sqrt{LC}}$

over damped $\frac{R}{2L} > \frac{1}{\sqrt{LC}}$

Critically damped $\frac{R}{2L} = \frac{1}{\sqrt{LC}}$

— 2M

PART-B

UNIT-I

2. a) $f(t) = e^{-at}\sin(\omega t)$

Laplace transform of $f(t) = \sin(\omega t)$

$$= \frac{\omega}{s^2+\omega^2}$$

By using Frequency shifting theorem

$\mathcal{L}\{f(t)\} = F(s)$, then $\mathcal{L}\{e^{-at}f(t)\} = F(s+a)$

$$\therefore \mathcal{L}\{e^{-at}\sin(\omega t)\} = \frac{\omega}{(s+a)^2+\omega^2}$$

(OR)

$$\mathcal{L}\{f(t)\} = \int_0^\infty e^{-st} f(t)\,dt$$

$$= \int_0^\infty e^{-st}\, e^{-at}\sin\omega t\,dt$$

$$= \int_0^\infty e^{-(s+a)t}\sin\omega t\,dt$$

$$= \left[\frac{e^{-(s+a)t}}{(s+a)^2+\omega^2}\left(-(s+a)\sin\omega t - \omega\cos\omega t\right)\right]_0^\infty$$

$$\mathcal{L}\{e^{-at}\sin\omega t\} = \frac{\omega}{(s+a)^2+\omega^2}$$ — (5M)

b) $f(t) = t^2 u(t-1)$

t^2 in terms of $(t-1)$

$\tau = t-1 \qquad$ so $t = \tau + 1$

Then $t^2 = (\tau+1)^2 = \tau^2 + 2\tau + 1$

Replace τ with t, $g(t) = t^2 + 2t + 1$

$f(t) = (t^2+2t+1)u(t-1) = g(t-1)u(t-1)$

Laplace transform of $g(t) = t^2 + 2t + 1$

$$\mathcal{L}\{t^2+2t+1\} = \mathcal{L}\{t^2\} + 2\mathcal{L}\{t\} + \mathcal{L}\{1\}$$

$$= \frac{2}{s^3} + \frac{2}{s^2} + \frac{1}{s}$$

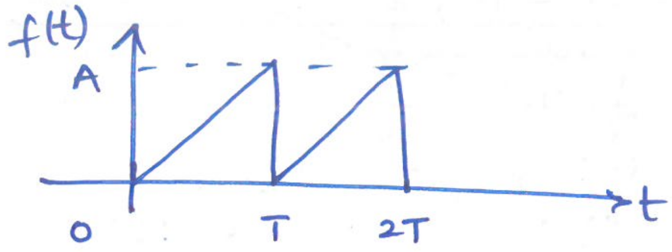
So,

By Apply the time-shifting property

$$\mathcal{L}\{t^2 u(t-1)\} = e^{-s} g(s) = e^{-s}\left(\frac{2}{s^3} + \frac{2}{s^2} + \frac{1}{s}\right)$$

—(5M)

3. Laplace transform of the periodic Sawtooth waveform



— 3M

$$f(t) = \frac{At}{T} \quad 0 < t < T$$

$$\mathcal{L}\{f(t)\} = \frac{1}{1-e^{-Ts}} \int_0^T f(t)\, e^{-st}\, dt \quad \text{— 2M}$$

$$= \frac{1}{1-e^{-Ts}} \int_0^T \frac{At}{T}\, e^{-st}\, dt$$

$$= \frac{1}{1-e^{-Ts}} \cdot \frac{A}{T} \int_0^T t\, e^{-st}\, dt$$

$$= \frac{1}{1-e^{-Ts}}\, \frac{A}{T} \left[\frac{t\, e^{-st}}{-s} \bigg|_0^T - \int_0^T \frac{e^{-st}}{-s}\, dt \right]$$

$$= \frac{1}{1-e^{-Ts}}\, \frac{A}{T} \left[\frac{t\, e^{-st}}{-s} \bigg|_0^T - \frac{1}{s^2}\, e^{-st} \bigg|_0^T \right]$$

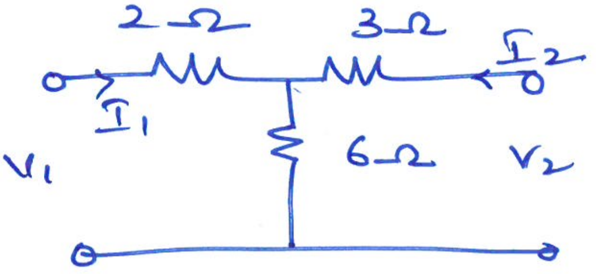
$$= \frac{A}{T(1-e^{-Ts})} \left[\frac{T e^{-sT}}{-s} + \frac{1}{s^2} - \frac{e^{-Ts}}{s^2} \right]$$

$$= \frac{A}{Ts^2} - \frac{A\, e^{-Ts}}{s(1-e^{-Ts})}$$

5M

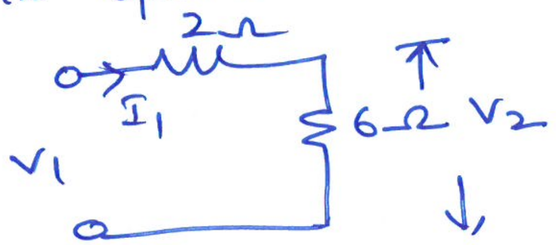
Note:- student may consider the time period of any value and magnitude A as of any value.

Unit-II

4. 

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$
$$V_2 = Z_{21} I_1 + Z_{22} I_2$$ — 2M

when output port is open circuited $I_2 = 0$



$R_{eq} = 2 + 6 = 8\,\Omega$

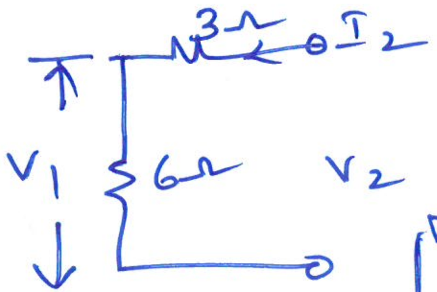
$V_1 = I_1 \times R_{eq}$

$$\boxed{Z_{11} = \frac{V_1}{I_1} = 8\,\Omega}$$ — 2M

$V_2 = 6 I_1$

$$\boxed{Z_{21} = \frac{V_2}{I_1} = 6\,\Omega}$$ — 2M

when input port is open circuited $I_1 = 0$



$R_{eq} = 3 + 6 = 9\,\Omega$

$V_2 = I_2 \times R_{eq}$

$$\boxed{Z_{22} = \frac{V_2}{I_2} = 9\,\Omega}$$ — 2M

$V_1 = 6 I_2$

$$\boxed{Z_{12} = \frac{V_1}{I_2} = 6\,\Omega}$$ — 2M

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 8 & 6 \\ 6 & 9 \end{bmatrix}$$

Note:- student can also use mesh & nodal analysis to obtain Z-parameters.

5.a) Conversion of Y-parameters into ABCD parameters.

Y-parameter equations are given by

$$I_2 = Y_{21}V_1 + Y_{22}V_2 \qquad \text{— 1M}$$

$$V_1 = \left(\frac{-Y_{22}}{Y_{21}}\right)V_2 + \left(-\frac{1}{Y_{21}}\right)(-I_2)$$

$$V_1 = \left(\frac{-Y_{22}}{Y_{21}}\right)V_2 - \left(-\frac{1}{Y_{21}}\right)I_2 \quad \text{—(1)}$$

& $I_1 = Y_{11}V_1 + Y_{12}V_2$ ~~1M~~

$$= Y_{11}\left[\left(\frac{-Y_{22}}{Y_{21}}\right)V_2 + \left(\frac{1}{Y_{21}}\right)I_2\right] + Y_{12}V_2$$

$$I_1 = \left[\frac{-Y_{11}Y_{22}-Y_{12}Y_{21}}{Y_{21}}\Big/ Y_{21}\right]V_2 - \left(-\frac{Y_{11}}{Y_{21}}\right)I_2$$

—(2)

Comparing equations (1) & (2) with the governing equations of ABCD parameters

$$A = \left(\frac{-Y_{22}}{Y_{21}}\right) \text{— 1M} \quad ; \quad B = \left(-\frac{1}{Y_{21}}\right) \text{— 1M}$$

$$C = \left[-\frac{Y_{11}Y_{22}-Y_{12}Y_{21}}{Y_{21}}\Big/ Y_{21}\right] \text{— 1M} \quad ; \quad D = \left(-\frac{Y_{11}}{Y_{21}}\right) \text{— 1M}$$

5.b) Given $Z = \begin{bmatrix} 10 & 5 \\ 3 & 8 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$

ABCD parameters for a two-port network

$$A = \frac{Z_{11}}{Z_{21}} = \frac{10}{3} \; ; \qquad \text{— 1M}$$

— 2M

$$B = \frac{Z_{22}Z_{11}-Z_{12}Z_{21}}{Z_{21}} = \frac{8\times10-5\times3}{3} = \frac{65}{3} = 21.67\,\Omega$$

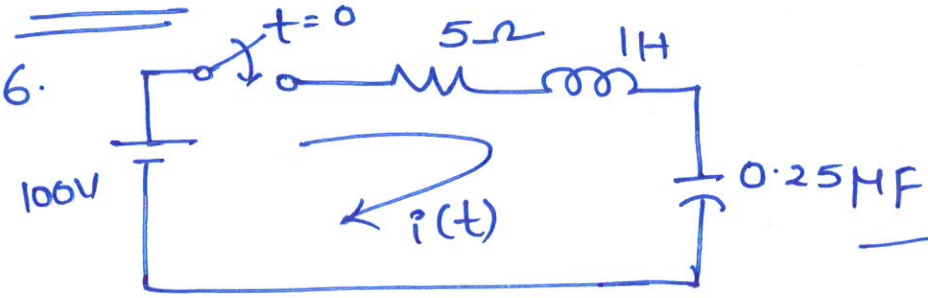
$$C = \frac{1}{Z_{21}} = \frac{1}{3}\ \mho \quad — 1M$$

$$D = \frac{Z_{22}}{Z_{21}} = \frac{8}{3} \quad — 1M$$

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} \frac{10}{3} & \frac{65}{3} \\ \frac{1}{3} & \frac{8}{3} \end{bmatrix}$$

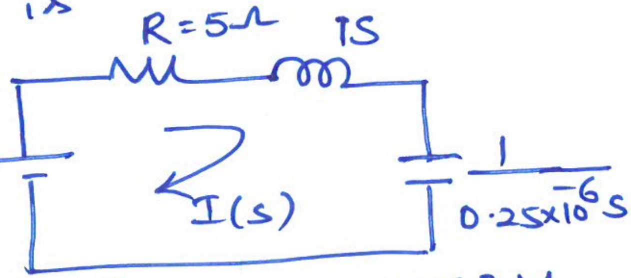
Unit-III

6.



— 2M

Transformed network is



— 2M

Applying KVL to the mesh

$$\frac{100}{s} = 5I(s) + sI(s) + \frac{1}{0.25\times10^{-6}s} I(s) \quad — 2M$$

$$\frac{100}{s} = 5I(s) + sI(s) + \frac{4\times10^{6}}{s} I(s)$$

$$\frac{100}{\cancel{s}} = \frac{s^2 I(s) + 5sI(s) + 4\times10^{6} I(s)}{\cancel{s}}$$

$$100 = (s^2 + 5s + 4\times10^{6}) I(s)$$

$$I(s) = \frac{100}{s^2+5s+4\times10^{6}}$$

$$s^2 + \cancel{20}5s + 4\times10^{6} = \frac{-5 \pm \sqrt{(5)^2 - 4(4\times10^{6})}}{2}$$

$$= -2.5 \pm j2000 \quad \& \quad -2.5 \pm j1999.99$$

The solution for this is $\quad \alpha = +2.5 \quad \beta = 2000$

$$i(t) = e^{-\alpha t}(A\cos\beta t + B\sin\beta t)$$

At $t=0$; $i(0)=0$, $A=0$

$\therefore\ i(t) = e^{-\alpha t} B \sin\beta t$

$i(t) = e^{-2.5t} B \sin 2000t$

$$\frac{di}{dt} = B e^{-2.5t}\, 2000 \cos 2000t - 2.5\, e^{-2.5t} B \sin 2000t$$

since the indu capacitor act as short ckt

$$V = V_L = 1\frac{di}{dt} = 100$$

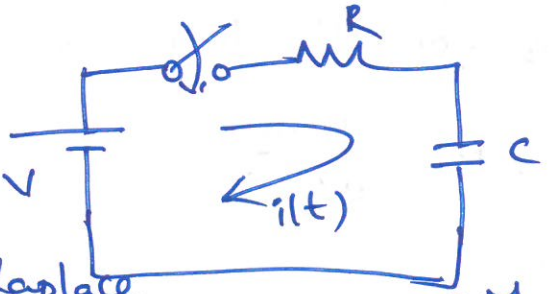
$$\therefore \frac{di}{dt} = 100$$

$$1\cancel{00} = B \times 2\cancel{000} \times 1$$

$$B = \frac{1}{20} = 0.05$$

$$\boxed{\therefore\ i(t) = 0.05\, e^{-2.5t} \sin 2000t} \quad \text{— 4M}$$

7. a)



— 2M

Laplace

Applying KVL to mesh after transforming to s-domain

$$\frac{V}{s} = R\,I(s) + \frac{1}{Cs} I(s) \quad \text{— 1M}$$

$$I(s) = \frac{V/s}{R + \frac{1}{Cs}}$$

$$= \frac{V/R}{s + 1/RC}$$

$$\therefore I(s) = \frac{V/R}{s + 1/RC}$$

Taking inverse Laplace transform

$I(t) = V$ [illegible] — 2M

(OR)

Applying KVL to loop

$$Ri + \frac{1}{C}\int i\,dt = V \quad \text{— (1)}$$

Differential

$$R\frac{di}{dt} + \frac{1}{C} i = 0$$

$$\left(P + \frac{1}{RC}\right) i = 0 \quad \text{— (2)}$$

The solution to this is

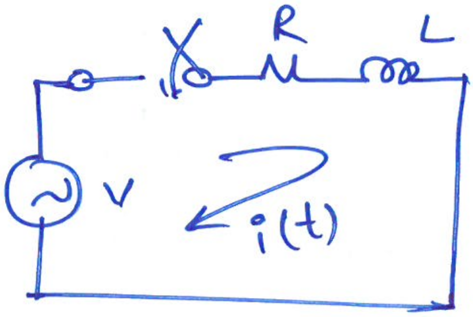
$$i = i_c = c\, e^{-t/RC}$$

at $t = 0^+$, $i(0^+) = \frac{V}{R}$.

$\therefore\ c = V/R$

$\therefore\ i = \frac{V}{R} e^{-t/RC}$ Amps.

7. b) $V = V_m \sin(\omega t + \theta)$



— 2M

Applying KVL

$$Ri + L\frac{di}{dt} = V_m \sin(\omega t + \theta)$$

$$\frac{R}{L} i + \frac{di}{dt} = \frac{V_m}{L} \sin(\omega t + \theta)$$

$$\left(p + \frac{R}{L}\right) i = \frac{V_m}{L} \sin(\omega t + \theta) \quad -(1)$$ — 1M

$$i_c = c e^{-R/L t} \quad -(2)$$

$$i_p = A\cos(\omega t + \theta) + B\sin(\omega t + \theta) \quad -(3)$$

$$\frac{di_p}{dt} \text{ or } p i_p = -A\omega \sin(\omega t + \theta) + B\omega \cos(\omega t + \theta) \quad -(4)$$

Sub eq(3) & eq(4) in eq(1)

$$\left(-A\omega + \frac{BR}{L}\right)\sin(\omega t + \theta) + \left(B\omega + \frac{AR}{L}\right)\cos(\omega t + \theta) = \frac{V_m}{L}\sin(\omega t + \theta)$$

equating coefficients of like terms & solving

$$A = \frac{-\omega L V_m}{R^2 + \omega^2 L^2} \quad ; \quad B = \frac{R V_m}{R^2 + \omega^2 L^2}$$

$$\therefore i_p = \frac{V_m}{\sqrt{R^2 + \omega^2 L^2}} \left[-\omega L \cos(\omega t + \theta) + R\sin(\omega t + \theta)\right]$$

Let $R = \cos\phi$ & $\omega L = \sin\phi$ $\quad \phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$

$$\therefore i_p = \frac{V_m}{\sqrt{R^2 + \omega^2 L^2}} \left[\sin\left(\omega t + \theta - \tan^{-1}\left(\frac{\omega L}{R}\right)\right)\right]$$

The complete solution is

$$i = c e^{-(R/L)t} + \frac{V_m}{\sqrt{R^2 + \omega^2 L^2}} \sin\left(\omega t + \theta - \tan^{-1}\left(\frac{\omega L}{R}\right)\right)$$

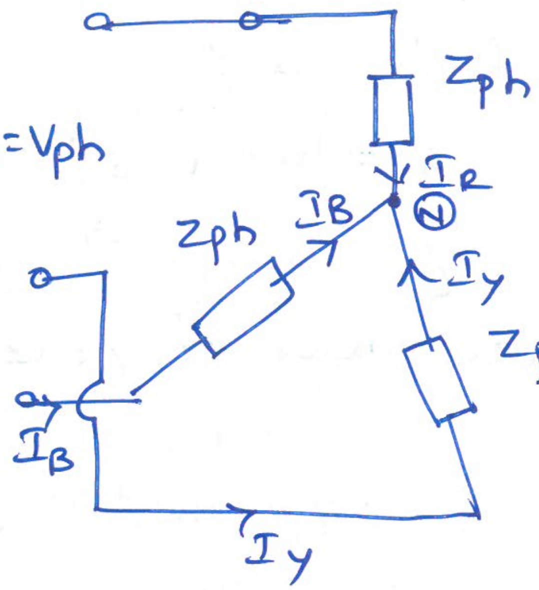
At $t=0$, $i_0 = 0$.

$$\therefore \; C = \frac{-V_m}{\sqrt{R^2+\omega^2L^2}} \sin\left(\theta - \tan^{-1}\left(\frac{\omega L}{R}\right)\right)$$

$$\therefore \; i = e^{-(R/L)t}\left[\frac{-V_m}{\sqrt{R^2+\omega^2L^2}} \sin\left(\theta - \tan^{-1}\left(\frac{\omega L}{R}\right)\right)\right] + \frac{V_m}{\sqrt{R^2+\omega^2L^2}} \sin\left(\omega t + \theta - \tan^{-1}\left(\frac{\omega L}{R}\right)\right)$$

— 2M

8. a)



Let $V_{RN} = V_{YN} = V_{BN} = V_{ph}$

$V_{RN} = V_{ph}\angle 0^\circ$

$V_{YN} = V_{ph}\angle -120^\circ$

$V_{BN} = V_{ph}\angle -240^\circ$

$V_{RY} = V_{YB} = V_{BR} = V_L$

— 2M

Applying KVL $V_{RY} = V_{RN} + V_{NY}$

$= V_{ph}\angle 0^\circ - V_{ph}\angle -120^\circ$

$= \sqrt{3}\,V_{ph}\angle 30^\circ$

Ily $V_{YB} = V_{BR} = \sqrt{3}\,V_{ph}\angle 30^\circ$. — 2M

It is clear from the above diagram that line current is equal to the phase current.

$I_L = I_{ph}$. — 1M

8. b) $W_1 = 1500W$ $W_2 = 750W$ della connected load

Total active power $= W_1 + W_2$

$= 1500 + 750$

$= 2250W$ — 2M

Total reactive power $Q_T = \sqrt{3}(W_1 - W_2)$

$= \sqrt{3}(1500 - 750)$

$= \sqrt{3}(750)$

$= 1299.04 VAR$ — 2M

power factor $\cos\phi$.

$$\phi = \tan^{-1}\left(\frac{Q}{P}\right)$$

$$\phi = \tan^{-1}\left(\frac{1299.04}{2250}\right) = 30^\circ$$

power factor $\cos\phi = \cos(30^\circ) = 0.866$.

(OR)

$$\cos\phi = \cos\left(\tan^{-1}\left(\frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right)\right)$$

$= 0.866$. — 1M

9. $Z_{ph} = 12 + j15$ Y - connected load

phase voltage $V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230.94$ — 1M

$Z_{ph} = 19.21 \angle 51.34$ — 1M

Line current = phase current

$I_L = I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{230.94}{19.21} = 12.02 \angle -51.34$ — 3M

Active power $P = \sqrt{3}\, V_L I_L \cos\phi$

$= \sqrt{3} \times 400 \times 12.02 \times \cos(51.34)$

$P = 5.2 KW$ — 3M

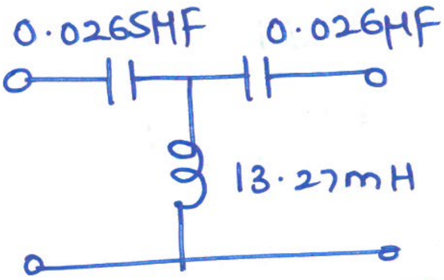
power factor $\cos\phi = \cos(51.34) = 0.62$ — 2M

10. a) $f_c = 3000\,Hz \qquad K = 500\,\Omega$

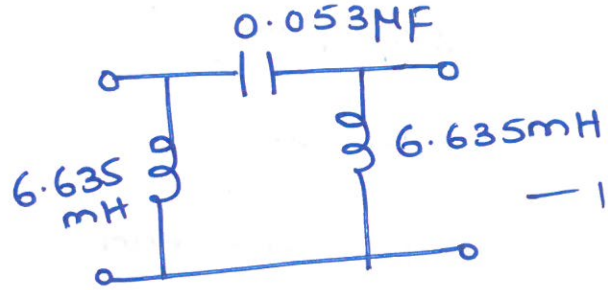
$$L = \frac{K}{4\pi f_c} = \frac{500}{4\pi \times 3000} = 13.27\,mH$$

$$C = \frac{1}{4\pi f_c K} = \frac{1}{4\pi \times 3000 \times 500} = 0.053\,\mu F$$

— 3

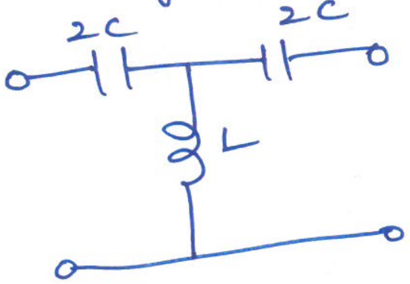


— 1M

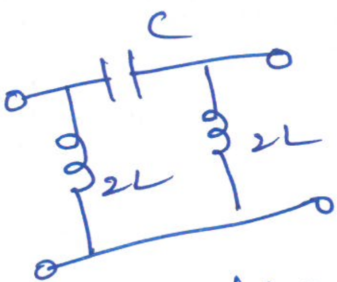


— 1M

10. b) Constant K-high pass filter.



T-section



π-section

— 1M

$$Z_1 = -j\frac{1}{\omega C} = \frac{1}{j\omega C}$$

$$Z_2 = j\omega L$$

1. Nominal impedance $K = \sqrt{Z_1 Z_2} = \sqrt{\frac{L}{C}}$

2. Cut-off frequency

when $\frac{Z_1}{4Z_2} = 0 \rightarrow f = \infty$

$\frac{Z_1}{4Z_2} = -1 \rightarrow f_c = \frac{1}{4\pi\sqrt{LC}}$

The pass band starts at $f = f_c$ & continues up to infinite frequency.

3. Attenuation constant :-

In pass band, $\alpha = 0$

In stop band, $\alpha = 2\cosh^{-1}\sqrt{\left|\frac{Z_1}{4Z_2}\right|}$

$= 2\cosh^{-1}\left(\frac{f_c}{f}\right)$

4. phase constant :-

In pass band, $\beta = 2\sin^{-1}\sqrt{\left|\frac{Z_1}{4Z_2}\right|}$

$= 2\sin^{-1}\left(\frac{f_c}{f}\right)$

In stop band, $\beta = \pi$

5. characteristic Impedance :-

$Z_{OT} = K\sqrt{1 - \left(\frac{f_c}{f}\right)^2}$

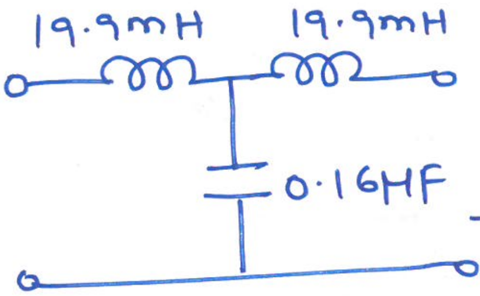
$Z_{O\pi} = \frac{K}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}}$

Note :- Allot full marks if student writen any two characteristics. each 2M.

11. $f_c = 4000\,Hz$ $\quad K = 500\,\Omega$

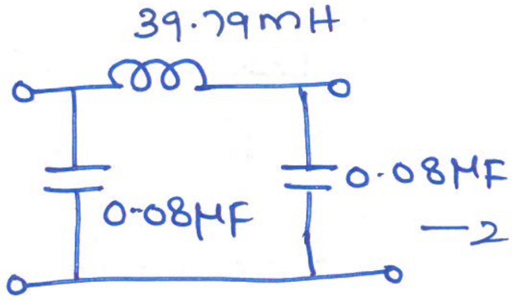
$$L = \frac{K}{\pi f_c} = \frac{500}{\pi \times 4000} = 39.79\,mH \quad -3M$$

$$C = \frac{1}{\pi f_c K} = \frac{1}{\pi \times 4000 \times 500} = 0.16\,\mu F \quad -3M$$



—2M

T-section



—2M

π-section